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(54) MICRO CONTACT LENS

(71) I, WILHELM PETER SOHNGES, of German Nationality, trading as the firm SOHNGES OPTIK WILHELM P. SOHNGES, of Blutenstrasse 11—15, D—8000, Munchen 40, Germany, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a micro contact lens (as hereinafter defined).

Micro contact lenses with optical hard lens cores were previously made of glass and, more recently, of plastics. As is known, such contact lenses constitute an excellent aid to vision, not only for the correction of short sight or long sight, but also for serious diseases of the eye such as miscurvature of the cornea. Such contact lenses may even to some extent be used as a complete replacement for the lens.

The hard lens which is optically preferred is only tolerated by the patient with difficulty, because the lens appears as a foreign body in the eye.

Also the edges of plastics lenses had to be specially worked, or otherwise points of pressure acted on the cornea.

Furthermore, when wearing contact lenses for long periods of time the normal flow of tear liquid is partly or completely stopped over the eye. As a result the necessary supply of oxygen to the cornea is considerably restricted. Such a continuous exchange of tear liquid is essential, because the cavity between the contact lens and the cornea is filled with tear liquid owing to capillary action to form a new lens on the eye surface.

Numerous forms of contact lens have already been tried in which holes were provided either in optic part or in the non-optic edge part of the lens (see for example German Offenlengungsschrift 2,151,028). However, these forms of contact lenses do not give a satisfactory exchange of tear liquid because the holes become blocked.

Furthermore the providing of hydrophilic tissue which surrounds the hard core does not solve the problem because there is a danger of bacterial contamination owing to irritation of the edges of the eyelids. In general, every exchange of liquid substantially perpendicular to the micro contact lens, in as far as there is such an exchange, on the one hand leads to the danger of bacterial contamination and on the other hand leads to insufficient exchange of tear liquid.

In addition for a lens with a hard core and a soft edge part owing to the presence of a plasticiser in the plastics, there is a lack of compatibility with respect to the eye. If, on the other hand, the lens is hydrophilic, there is a danger that the lens would take up bacteria.

German Patent Specification 701,970 describes a contact lens which operates with self-adapting flexible plastics extending over the cornea and sclera and onto which a hard lens is pressed into position through a groove. However, there is no exchange of liquid since the eyelids cannot move the hard lens and thus pump tear liquid underneath the lens.

The present invention provides a micro contact lens (as hereinafter defined) comprising an optic hard lens core surrounded by a flexible annular peripheral edge part, the peripheral edge part being made of material which is compatible with respect to the eye, wherein the lens is contructed as a sphere on the cornea side approximately in the zone of the hard lens core, a parabola zone extending from the hard lens core over the flexible peripheral edge part, the parabola zone merging at the edge with a bevel zone.

In this specification, by a "micro contact lens" is meant a corneal lens wherein the supporting edge part of the lens rests on the

optic part of the eye, i.e. on the cornea, as opposed to a scleral lens wherein the supporting edge part of the lens rests on the sclera of the eye.

Preferably the lens core has a diameter of from 6 to 10 mm.

Small channels may be provided on the cornea side, which channels extend over the whole peripheral edge part radially with respect to the hard core, the channels being formed by corrugations. A corrugated edge favours access of tear liquid and thus its exchange.

It is convenient if the parabola begins in the outermost third of the micro contact lens diameter.

The outer periphery of the hard core can run obliquely to form a large contact surface with the flexible peripheral edge part. Alternatively the periphery of the hard core may be triangular in cross-section as seen in a side view of the lens, and the shorter limb of the triangle may run towards the inner side of the lens. In a further alternative arrangement, the periphery of the hard core may be semi-circular in cross-section as seen in a side view of the lens.

For minus lenses, the periphery of the hard core may be triangular in cross-section as seen in a side view of the lens, the apex of the triangle subtending an obtuse angle. Alternatively, the periphery of the hard core may be constructed in the form of a V-shaped groove. In a further alternative arrangement, the periphery of the hard core may have a projection which fits into a corresponding recess in the flexible peripheral edge part.

The peripheral edge part may be polymerised onto the lens core. The effect of the incompatibility of plasticiser with the eye can be avoided if the peripheral flexible edge part is formed by applying two liquid components A and B to produce a plastics material, where A is preferably an aliphatic isocyanate and B is preferably a polyacrylate. The hard core is substantially a polymethacryiate.

The connection between the flexible peripheral edge part and the hard core can be improved by arranging that during polymerisation a small part of the plastics forms a plug connection through a hole in the hard core.

The flexible peripheral edge part can also be produced by polymerisation, by other connections produced chemically, by induction welding or by any melting or pressing process which produces a close connection between the edge of the hard lens and the flexible peripheral edge part.

With the micro contact lens in accordance with the invention, closing of the eyelids moves the hard lens backwards and forwards, the lens lying in a relatively flat manner on the eyeball which is spherical at least in the cornea zone. Despite the flexible peripheral edge part a satisfactory exchange of tear liquid is maintained, and there is therefore a sufficient supply of oxygen to the cornea.

The micro contact lens in accordance with the invention is therefore pleasant to wear, compatible, impermeable to bacteria, and allows an adequate exchange of tear liquid. The lens even rejects bacteria, since it does not offer any place where the bacteria can settle.

Despite the flexible peripheral edge part, the pumping effect of the lens by the beat of the eyelids remains unimpaired and accordingly tear liquid enriched with oxygen can supply the cornea behind the lens sufficiently.

A particular advantage can be achieved if the provision of a corrugated edge is combined with parabolic construction beginning in the last third of the hard lens diameter. The corrugations can be produced even during the polymerisation itself.

If the flexible peripheral edge part is polymerised by employing two liquid components, the corrugations or small channels can be formed at the same time. The polymerisation preferably occurs on a hard substrate, for example a metallically coated part sphere. Subsequent working is not carried out because of the flexible material. The stresses to be expected by welding do not occur.

The invention will be further described, by way of example only with reference to the accompanying drawings, in which:—

Figures 1, 2 and 3 are side views of plus contact lenses with different forms of connection;

Figures 4, 5 and 6 are side views of minus contact lenses with different forms of connection; and

Figure 7 shows a plan and side views of another contact lens.

The contact lens shown in Figure 1 is spherical at the apex at 1 and approximately 3.0 mm from the apex is formed as a parabola with a smooth transistion 2. The parabola also extends over a flexible peripheral edge part 3, which is polymerised onto the hard lens 4.

The edge 5 of the hard lens 4 is cut off obliquely, with the result that there is a large straight contact surface between the hard lens and the peripheral edge part. The peripheral edge part tapers and ends in a rounded-off bevel zone 6. The bevel zone is adjoined by the parabola zone and an optic zone. The breadth of the annular flexible edge part is for example 1 mm and the thickness of the lens at the apex 1 is approximately 0.4 mm.

The contact lens shown in Figure 2 is chamfered in a triangular fashion in cross-section, i.e. chamfered from two sides, and the shorter limb of the triangle extends from the inner curve of the lens.

The oblique face of the upper limb of the triangle is approximately the same as that shown in Figure 1. As a result, independently of the actual connection, the strength of the flexible peripheral edge part is substantially increased, since the lens edge serves practically as a stabilising core for the flexible peripheral edge part. This lens has at the apex 7 a radius of the inner curve of for example 8.5 mm and has a thickness at 8 of 0.35 mm. The optical strength is 3.0 diopters. The breadth of the annular edge part 9 is 1 mm. In other respects the construction is similar to that shown in Figure 1.

In order to still further increase the strength of the connection between the hard lens core and the peripheral edge part the hard lens is provided at some positions with holes 10 (indicated only notionally in Figure 2) through which for example is inserted plastics material which is polymerised on to create plug-like connections between the plastics above and below the lens core.

The contact lens shown in Figure 3 is ground and polished in a round fashion at the peripheral edge surface 11 of the hard core, which also forms a large contact surface. The edge is semi-circular in cross-section.

The contact lens shown in Figure 4 has a blunt edge transition at 12. The peripheral edge part is broader than the hard core of the lens. The ratio of twice the breadth of the annular peripheral edge part to the diameter of the hard lens core is approximately 5.5:10. The spherical course is indicated again at 13.

In the contact lens shown in Figure 5 the hard lens core 14 has formed in its periphery a notch 15 into which the peripheral flexible edge part 16 fits, the hard core 14 being connected to the peripheral part 16 with adhesive for example.

A particularly strong form of the transition is apparent from the contact lens shown in Figure 6. The edge of the hard lens 17 has a projection 18 which fits into a corresponding recess in the peripheral edge part.

Figure 7 shows a lens with a corrugated edge 19. The corrugated edge is particularly suitable for the supply of tear liquid.

In the case of some of the lenses described above, the flexible peripheral edge part is made up by applying two liquid components A and B onto the hard core, where A is an aliphatic isocyanate and B is a polyacrylate having central hydroxyl groups. The polyacrylate may be a polymethyl methacrylate or a modified polymethyl methacrylate, which is polymerised by heating at 40 to 80°C. A polycarbonate is also suitable.

In addition to the normal contact lenses it is also possible to produce colour lenses, cosmetic lenses, or toroidal or multifocal lenses.

WHAT I CLAIM IS:—

1. A micro contact lens (as hereinbefore defined) comprising an optic hard lens core surrounded by a flexible annular peripheral edge part, the peripheral edge part being made of a material which is compatible with respect to the eye, wherein the lens is constructed as a sphere on the cornea side approximately in the zone of the hard lens core, a parabola zone extending from the hard lens core over the flexible peripheral edge art, the parabola zone merging at the edge with a bevel zone.

2. A contact lens as claimed in Claim 1 wherein the lens core has a diameter of from 6 to 10 mm.

3. A contact lens as claimed in Claim 1 or 2 wherein channels are provided on the cornea side, which channels extend over the whole edge part radially with respect to the hard core, the channels being formed by corrugations.

4. A contact lens a claimed in any of Claims 1 to 3 wherein the parabola begins in the outermost third of the contact lens diameter.

5. A contact lens as claimed in any of Claims 1 to 4 wherein the lens internal curve is flatter than the cornea.

6. A contact lens as claimed in any of Claims 1 to 5 wherein the outer periphery of the hard core runs obliquely to form a large contact surface with the flexible peripheral edge part.

7. A contact lens as claimed in any of Claims 1 to 5 wherein the periphery of the hard core is triangular in cross-section as seen in a side view of the lens, the shorter limb of the triangle running towards the inner side of the lens.

8. A contact lens as claimed in any of Claims 1 to 5 wherein the periphery of the hard core is semi-circular in cross-section as seen in a side view of the lens.

9. A contact lens as claimed in any of Claims 1 to 5 wherein for a minus lens the periphery of the hard core is triangular in cross-section as seen in a side view of the lens, the apex of the triangle subtending an obtuse angle.

10. A contact lens as claimed in any of Claims 1 to 5 wherein, for a minus lens, the periphery of the hard core is constructed in the form of a V-shaped groove.

11. A contact lens as claimed in any of Claims 1 to 5 wherein, for a minus lens, the periphery of the hard core has a projection

which fits into a corresponding recess in the flexible peripheral edge part.

12. A contact lens as claimed in any of Claims 1 to 11 wherein the flexible peripheral edge part is polymerised onto the hard lens core.

13. A contact lens as claimed in Claim 12 wherein the peripheral flexible edge part is formed by applying two liquid components A and B on the hard core, wherein A is an aliphatic isocyanate and B is a polyacrylate.

14. A micro lens substantially as herein described with reference to, and as shown in, any of Figures 1 to 7 of the accompanying drawings.

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1417650 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

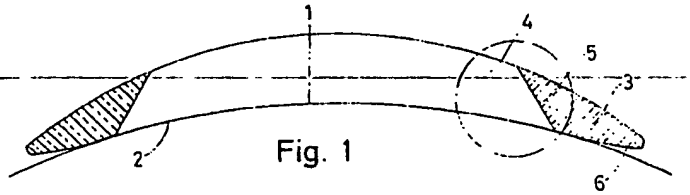

Fig. 1

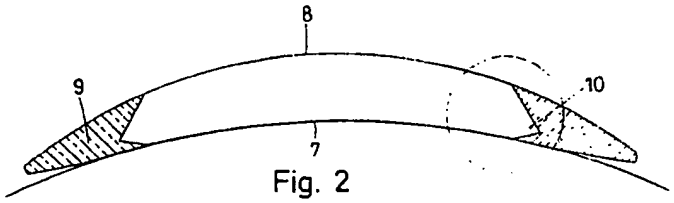

Fig. 2

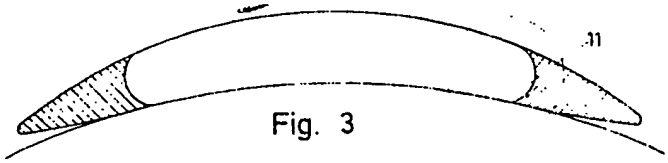

Fig. 3

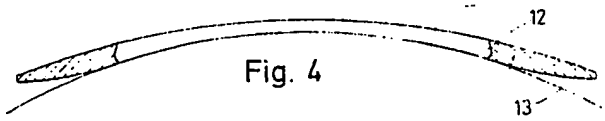

Fig. 4

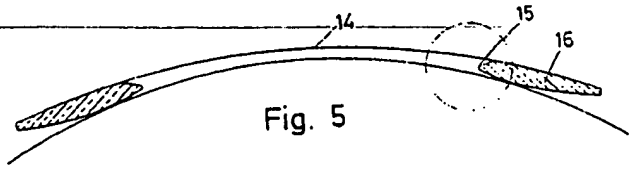

Fig. 5

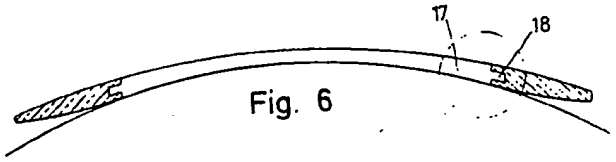

Fig. 6

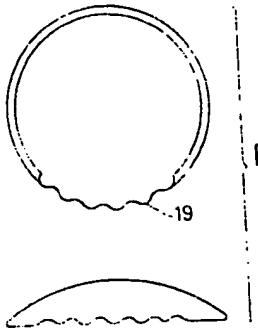

Fig. 7